Amendments to the Specification

Please insert the following heading above between the first and second paragraphs on page 1:

--BACKGROUND OF THE INVENTION--;

On page 2, on line 23, please insert the following heading:

--BRIEF SUMMARY OF THE INVENTION--;

Please replace the paragraph beginning on page 2, line 36, in the Specification as filed with the following amended paragraph:

By way of the fact that the fuel cell system is designed as a composite of a first, anode-side ~~[printed]~~ printed circuit board and of a second, cathode-side ~~[printed]~~ printed circuit board, on the one hand the number of different components which are to be produced during manufacture of such a system is reduced and thus the manufacturing is simplified, and on the other hand it is rendered possible to construct electronic circuits on the ~~[printed]~~ printed circuit board composite. These may possibly obtain the energy for the operation of the circuit from the fuel cell system itself.

Please replace the paragraph beginning on page 3, line 6, in the Specification as filed with the following amended paragraph:

According to the character of the realisation of the fuel cell system according to the invention in ~~[printed]~~ printed circuit board technology, current collectors which are required for the electron transport in the fuel cell, and connecting lugs via which the fuel cells contained in the fuel cell systems are connected to one another in series in a plane, are realised as strip conductors of the ~~[printed]~~ printed circuit boards from which the ~~[printed]~~ printed circuit board composite is constructed.

Please replace the paragraph beginning on page 3, line 13, in the Specification as filed with the following amended paragraph:

Within the context of this application, a ~~[printed]~~ printed circuit board in ~~[printed]~~ printed circuit board technology indicates a board, consisting of a ~~[printed]~~ printed circuit board carrier (substrate) with a deposited metallisation, wherein usually parts of the metallisation are removed, e.g. by way of an. etching method or by way of milling, so that the remaining metallisation part forms an electrically conductive strip conductor. Such metallisations or strip conductors may be located on the first and/or second side of a ~~[printed]~~ printed circuit board.

Please replace the paragraph beginning on page 3, line 31, in the Specification as filed with the following amended paragraph:

The fuel cell system may advantageously be developed further to the extent that the connecting lugs are located within the boundary of the ~~[printed]~~ printed circuit board composite, thus the connecting lugs do not project beyond the outline of the ~~[printed]~~ printed circuit board composite. The mechanical robustness may thus be further improved and the expense with regard to technology may be reduced further with its practical application and with the further processing.

Please replace the paragraph beginning on page 4, line 1, in the Specification as filed with the following amended paragraph:

If the fuel cell system is advantageously developed further to the extent that the horizontally overlapping connecting lugs in their overlapping region in each case are connected by way of at least one contacting element, the connecting lugs are well defined with regard to one another and are brought into connection with one another in a lasting manner and thus the electrical series connection is realised in a manner in accordance with ~~[printed]~~ printed circuit board construction. The contacting element is particularly advantageous when it is used in combination with the advantageous further development of the fuel cells in each case having a reaction region

incorporated into the ~~[printed]~~ printed circuit board, said reaction region being bordered by a raised part of ~~[printed]~~ printed circuit board material and/or lacquer, since then, on account of the perpendicular contacting elements, the arising vertical distance between the overlapping connecting lugs of two fuel cells contained in the fuel cell system is bridged. The contacting element may advantageously be realised with a perpendicular design. It is however not limited to such a design.

Please replace the paragraph beginning on page 4, line 34, in the Specification as filed with the following amended paragraph:

It is further advantageous to provide several contactings for each connection of two overlapping connecting lugs, by which means the respective transition resistance is reduced further. .An alternative, advantageous perpendicular contacting element is a rivet or press pin which additionally also contributes to the mechanical strength with respect to the cohesion of the composite of the ~~[printed]~~ printed circuit boards.

Please replace the paragraph beginning on page 5, line 12, in the Specification as filed with the following amended paragraph:

Advantageously, gas distributor structures may be incorporated into the first anode-side ~~[printed]~~ printed circuit board and into the second cathode-side ~~[printed]~~ printed circuit board, wherein the second, cathode-side ~~[printed]~~ printed circuit board additionally or in place of the gas distributor structures may comprise air openings to the outside of the fuel cell system.

Please replace the paragraph beginning on page 5, line 18, in the Specification as filed with the following amended paragraph:

If the fuel cells of the fuel cell system in each case comprise a reaction region incorporated into the ~~[printed]~~ printed circuit board, which is bordered by a raised part of ~~[printed]~~ printed circuit board material and/or lacquer defining the reaction region,

then a pocket arises on account of this which defines the reaction region and furthermore renders possible an improved fixation and an improved assembly of the diffusion layer in the reaction region, as is provided for in a :further advantageous embodiment.

Please replace the paragraph beginning on page 5, line 32, in the Specification as filed with the following amended paragraph:

The raised part of ~~[printed]~~ printed circuit board material and/or lacquer may in a practically particularly advantageous form be an interconnected frame structure, wherein the applied material may be plastic, FR4, impregnated paper or similar material which are laminated on or bonded on, epoxy adhesive which is printed on, or furthermore solder blocking lacquer.

Please replace the paragraph beginning on page 6, line 18, in the Specification as filed with the following amended paragraph:

For separating off the anode side from the cathode side in each case of one reaction space which is realised by a first, anode-side and an analogously constructed second, cathode-side ~~[printed]~~ printed circuit board, for the composite of the two ~~[printed]~~ printed circuit boards, a proton-conductive polymer membrane is applied between these ~~[printed]~~ printed circuit boards which only has catalytically coated segments in the region of the reaction spaces of the fuel cells in the fuel cell system. At the same time, preferably a segmented membrane electrode assembly (MEA) is used. With this, this membrane is not penetrated by the current path, i.e. by the strip-conductor-like current collectors and connecting lugs or by the perpendicular connection elements which connect the horizontally overlapping connecting lugs of two fuel cells.

Please replace the paragraph beginning on page 6, line 32, in the Specification as filed with the following amended paragraph:

By way of the fact that a first and a second ~~[printed]~~ printed circuit board carrier (substrate) in each case is selected with an upper side and a lower side and for both carriers (substrates) a number of equal method steps is carried out in each case on the upper side, one may reduce the expense for manufacture with industrial large-scale production. This is accomplished by way of manufacturing several fuel cell systems from a single ~~[printed]~~ printed circuit board (multiple use).

Please replace the paragraph beginning on page 7, line 1, in the Specification as filed with the following amended paragraph:

By way of the fact that the ~~[printed]~~ printed circuit board carrier (substrate) in each case is provided with a metallisation so that a ~~[printed]~~ printed circuit board within the context of the present invention arises, and by way of the fact that this metallisation is selectively etched away in part regions of the ~~[printed]~~ printed circuit board so that strip conductors arise, in a reliable manner capable of series production, current collectors realised as a strip conductors and likewise strip-conductor-like connecting lugs which are contiguous with these in a smooth manner are produced in the reaction spaces.

Please replace the paragraph beginning on page 7, line 13, in the Specification as filed with the following amended paragraph:

By way of the fact that gas distributor structures are incorporated into the ~~[printed]~~ printed circuit board, the reactands are led to the reaction space and distributed here. The incorporation may for example be effected by way of milling, wherein in the case of a thin strip conductor in the reaction region (for example about 30 µm to 100 µm) one mills through the plane of the strip conductor in the direction of

the ~~[printed]~~ printed circuit board lower side, and in the case of a thick strip conductor layer (e.g. 200 µm to 500 µm) one mills or etches into the strip conductor layer itself.

On page 8, line 4, please insert the following heading:

--BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS--;

Please replace the paragraph beginning on page 8, line 5, in the Specification as filed with the following amended paragraph:

The present invention is explained hereinafter by way of several embodiment examples with figures. There are shown in

Fig. 1 the schematic construction of a fuel cell with ~~[printed]~~ printed circuit board technology, in a cross section, which according to the invention is designed as a composite of two ~~[printed]~~ printed circuit boards,

Fig. 2 the schematic construction of the anode-side ~~[printed]~~ printed circuit board, in a plain view,

Fig. 3 the schematic cross section in the region of the reaction space and of the MEA of a first embodiment form of a fuel cell system according to the invention, with three fuel cells, which are connected in series in a plane,

Fig. 4 the schematic cross section in the region outside the membrane electrode assembly (MEA) through a first embodiment of a fuel cell

system according to the invention, with three fuel cells, which are connected in series in a plane,

Fig. 5 the schematic upper and lower view of one of the two ~~[printed]~~ printed circuit boards shown in Fig. 4, of the ~~[printed]~~ printed circuit board composite, without a deposited raised part, diffusion layer and MEA.

Fig. 6 the schematic cross section of a second embodiment form of the fuel cell system according to the invention, with which three fuel cells in the ~~[printed]~~ printed circuit board composite are not only connected electrically in series in a plane via inner-lying connecting lugs, but also via strip conductors on the surface of the ~~[printed]~~ printed circuit board composite,

Fig. 7 the view of the upper and lower side of one of the two ~~[printed]~~ printed circuit boards of the ~~[printed]~~ printed circuit board composite in Fig. 6 without the deposited raised part, diffusion layer and without MEA,

Fig. 8 the schematic cross section of a third· embodiment form of the fuel cell system according to the invention, with which in the [printed] circuit board composite three fuel cells are connected electrically in series in. a plane not only by way of inner lying connecting lugs, but also via strip conductors which are on the reaction region side and. which face one another, on the respective sides, which face one another, of the anode-side and cathode-side ~~[printed]~~ printed circuit board, and which are welded from an opening accessible to the outside~~.~~,

Fig. 9 the view of the upper and lower side of one of the two ~~[printed]~~ printed circuit boards of the ~~[printed]~~ printed circuit board composite in Fig. 8 without diffusion layer and MEA, but with the deposited raised part,

Fig. 10 the schematic cross section in the region of the reaction space of a fourth, alternative embodiment of the fuel cell system according to the invention, with four fuel cells whose anodes and cathodes are arranged alternately on an upper and lower ~~[printed]~~ printed circuit board, and are connected in series in a plane by way of connection of the current collectors of two adjacent anodes and cathodes by way of a strip conductor.

On page 9, line 20, please insert the following heading:

--DETAILED DESCRIPTION OF THE INVENTION--;

Please replace the paragraph beginning on page 9, line 21, in the Specification as filed with the following amended paragraph:

Fig. 1 shows a schematic cross section through a fuel cell with ~~[printed]~~ printed circuit board technology, which is designed as a composite of a first, anode-side ~~[printed]~~ printed circuit board 10 and a second, cathode-side [printed] circuit board 11. The two oppositely lying ~~[printed]~~ printed circuit boards 10 and 11, which in this case are constructed in a completely equal manner and are deposited onto one another rotated by 180° to one another about the spatial vertical, in their reaction region are separated by the membrane electrode assembly (MEA) 3 and are connected to one another at the edges. The common reaction region formed by the two ~~[printed]~~ printed circuit boards 10 and 11 of the ~~[printed]~~ printed circuit board composite at the same time consist of the gas distributor structures 6, the current collectors 1 and the diffusion layers 2 of both ~~[printed]~~ printed circuit boards as well as of the previously mentioned MEA 2 with the porous catalytic coating 4.

Please replace the paragraph beginning on page 10, line 8, in the Specification as filed with the following amended paragraph:

The diffusion layer may at the same time consist of carbon-fibre paper, preferably however also may be designed as a plastic fabric 2' which in the region of the ~~electrodes~~ current collector 1 has metallised segments (e.g. gold, nickel gold); Suitable plastic fabric of polyamide or nylon with diameters of the threads in the region between 20 µm and 100 µm and mesh widths of between 30 µm and 500 µm are used as screen printing fabric. Although methods for the permanent metallisation of such

fine plastic fabrics are known, the segment structure may be achieved by way of a masking or photolithography of the plastic fabric which precede the metallisation.

Please replace the paragraph beginning on page 10, line 16, in the Specification as filed with the following amended paragraph:

In this example, advantageously the diffusion layer 2 is electrically contacted and also mechanically fastened to the current collector 1 by way of soldering or electrically conductive adhesive. In order to better fix the diffusion layers and to simplify the assembly of the diffusion layer, the diffusion layers may be surrounded by a raised part 13 of ~~[printed]~~ printed circuit board material, so that in each case a recess (pocket) arises in the part of the ~~[printed]~~ printed circuit boards 10 and 11 which forms the reaction space, and thus a frame structure is formed. This frame structure is characterised by the distance of the bonding joint 7 to the plane of the current collector 1 and by nature is located outside the reaction region. This frame structure may be realised by way of laminating-on or bonding-on plastic, FR4, impregnated paper or similar material, by way of printing-on epoxy adhesive, solder-blocking lacquer or similar means.

Please replace the paragraph beginning on page 11, line 1, in the Specification as filed with the following amended paragraph:

The contacts 5 and 5' serve for the external electrical connection of the fuel cell system and are electrically bonded to the current collectors 1. Commercially available and standardised clamp contacts, connecting lugs, pins, rivets etc. may be used as outer contacts 5 and 5'. In Fig. 1, the attachment of a lateral outer contact 5 and alternatively to this, the attachment of a perpendicular outer contact 5' to the outer side of the ~~[printed]~~ printed circuit board is represented, which are connected to the strip conductor by way of soldering or riveting.

Please replace the paragraph beginning on page 11, line 15, in the Specification as filed with the following amended paragraph:

Fig. 2 shows the anode-side ~~[printed]~~ printed circuit board 10 of the fuel cell system of Fig. 1 in a plan view. Recesses of the gas distribution structure 6 are incorporated into the plane of the current collector 1 and the ~~[printed]~~ printed circuit board material lying thereunder. The membrane electrode assembly is not drawn in this representation, but its position in indicated by the dashed line 3'. In the present embodiment, the gas distribution structure bas a meandering course. The mechanically deposited raised part 13 forming a frame structure and surrounding the reaction space covers the current collector 1 in the edge regions. For this reason the current collector 1 in the plan view may only be recognised in the region of the reaction space. The current collector 1 covered by the frame structure is laterally connected to the current discharge contact 5.

Please replace the paragraph beginning on page 11, line 26, in the Specification as filed with the following amended paragraph:

Fig. 3 shows a fuel cell system with ~~[printed]~~ printed circuit board technology which as a composite of an anode-side ~~[printed]~~ printed circuit board 10 and a cathode-side ~~[printed]~~ printed circuit board 11 is basically constructed analogously to the example shown in Fig. 1. Here three fuel cells are shown in a plane which are connected electrically in series outside the region of the membrane electrode unit (MEA) but within the ~~[printed]~~ printed circuit board composite.

Please replace the paragraph beginning on page 11, line 36, in the Specification as filed with the following amended paragraph:

The proton-conductive polymer membrane 3 is preferably designed as a segmented MEA 3" which is segmented in a manner such that the MEA 3" only has catalytically coated segments 4 in the region of the reaction spaces of the fuel cell system. The segmentation may at the same time be advantageously incorporated into an MEA which has been catalytically coated over the whole surface, such as by way of laser ablation or reactive ion etching (RIE).

Please replace the paragraph beginning on page 12, line 5, in the Specification as filed with the following amended paragraph:

Instead of a cathode-side gas distribution structure, the embodiment example has air openings 9 to the outside of the ~~[printed]~~ printed circuit board composite. The ~~[printed]~~ printed circuit boards 10 and 11 are screwed to one another or bonded under pressure, to reduce the contact resistance at the edge. Connection joints 7 arise.

Please replace the paragraph beginning on page 12, line 13, in the Specification as filed with the following amended paragraph:

Fig. 4 shows a schematic cross section outside the MEA through a fuel cell system of three fuel cells, with ~~[printed]~~ printed circuit board technology. Here a preferred way of electrically connecting the fuel cells in series in a plane outside the region of the MEA is represented.

Please replace the paragraph beginning on page 12, line 18, in the Specification as filed with the following amended paragraph:

This is effected in that the copper strip conductor of the current collector 1 is led into the outside of the reaction region but permanently in the inside of the boundary of the ~~[printed]~~ printed circuit board composite. Thus the connecting lug 8' of the ~~[printed]~~

printed circuit board 11 arises. The copper strip conductor of the fuel cell in the middle in Fig. 3 is likewise led outwards whilst forming the connecting lug 8. The connecting lugs 8 and 8' lie opposite one another in the vertical direction, thus overlap in a horizontal manner. At the same time the connecting lugs 8 and 8' are connected by way of perpendicular contacting elements 12 for creating the electrical contact.

Please replace the paragraph beginning on page 12, line 27, in the Specification as filed with the following amended paragraph:

In order not to penetrate the membrane electrode assembly (MEA) 3, the strip conductor of the current collector 1 is led in the region outside the polymer membrane or MEA 3 in the form of a connecting lug 8, into the intermediate space of two adjacent fuel cell assemblies. A bore 12 is formed through the ~~[printed]~~ printed circuit board composite for contacting the oppositely lying strip conductor lugs 8, 8'.

Please replace the paragraph beginning on page 13, line 4, in the Specification as filed with the following amended paragraph:

The contacting by way of a contact element 12 in the form of an electrically conductively filled bore may be advantageously varied to the extent that before joining together the ~~[printed]~~ printed circuit boards 10 and 11, on the reaction-space side, one drills in each case a bore with a larger diameter so that a larger surface of the connecting lugs 8 and 8' is released. Then, by way of a bore of a smaller diameter one creates a continuous bore from the opposite side, wherein the thinner bore lies coaxially in the thicker bore and the thinner bore penetrates the connecting lugs 8 and 8'. By way of filling with solder or conductive adhesive, then, as previously described, the contacting of the two connecting lugs 8 and 8' to one another may be carried out. On account of the thicker, first bore, as a whole a larger surface of the connecting lugs facing one another is released and thus an improved electrical contacting is achieved.

Please replace the paragraph beginning on page 13, line 21, in the Specification as filed with the following amended paragraph:

If the contacting element 12 instead of a filled bore is realised by a rivet or press pins, then simultaneously for the electrical contacting the pressing pressure of the ~~[printed]~~ printed circuit board composite is also realised. Furthermore, this possibility has a very low contact resistance and no temperature loading on assembly. If the ~~[printed]~~ printed circuit board material is removed between a connecting lug 8 and the surface of a ~~[printed]~~ printed circuit board 10 or 11 on the reaction region side, then a welding connection is also possible. For connecting the ~~[printed]~~ printed circuit boards 10 and 11, a clamping connection is alternatively or additionally conceivable.

Please replace the paragraph beginning on page 13, line 30, in the Specification as filed with the following amended paragraph:

Fig. 5 shows the plan view of the surface of the ~~[printed]~~ printed circuit board 10, said surface lying on the reaction region side (II) and lying on the outside (I) in the ~~[printed]~~ printed circuit board composite, without a deposited raised part, without diffusion layers 2 and without MEA 3, wherein the position of the MEA is indicted by the dashed line 3'.

Please replace the paragraph beginning on page 14, line 4, in the Specification as filed with the following amended paragraph:

In the view (II) on the reaction region side, the strip conductor which surrounds the serpentine gas distribution structure and forms the current collector 1 may be recognised. This strip conductor 1 merges smoothly into the connecting lugs 8, in the drawing in each case on the right at the top and on the right at the bottom of the reaction region with the gas distribution structure 6 and the current collector 1. The reaction region whose boundary in this figure is represented by the rectangle formed

by the gas distribution structure 6 and the current collector 1, lies in the pocket which circumscribes this reaction region and which is formed by the raised part of ~~[printed]~~ printed circuit board material which is not shown in more detail in this figure. The gas distribution structure at the same time penetrates this raised part forming the pocket at the location where two fuel cells are connected to one another with regard to the supply of reactands.

Please replace the paragraph beginning on page 14, line 21, in the Specification as filed with the following amended paragraph:

It is to be clearly seen that the electrical circuiting by way of the connecting lugs 8 takes place outside the reaction region but within the outer boundary of the ~~[printed]~~ printed circuit board 10. By way of this one not only achieves the advantage that on account of the electrical contacting, the MEA 3' indicated only in its position in this figure is not penetrated and by way of this leakages may not arise, but also the usually high electrical losses in a planar arrangement of series connected fuel cells is avoided by way of the fact that the current through the preferably used well-conducting copper strip conductors which are formed by the current collectors 1 and the connecting lugs 8 is discharged to the edge.

Please replace the paragraph beginning on page 14, line 31, in the Specification as filed with the following amended paragraph:

The Figures 6 and 7 show a second embodiment. Here the inner-lying connecting lugs 14 and 14' of the ~~[printed]~~ printed circuit boards 10 and 11 are shown similarly to that in Figures 4 and 5, but the inner-lying connecting lugs 14 and 14' (see Fig. 7) only form an extension of the current collectors to the outer region and no longer have the lateral, extension bent at an angle, in the direction of the adjacent fuel cell of the connecting lugs 8 and 8' of Figures 4 and 5.

Please replace the paragraph beginning on page 15, line 14, in the Specification as filed with the following amended paragraph:

Figures 8 and 9 show a third embodiment form. Here the inner-lying connecting lugs 17 and 17' of the ~~[printed]~~ printed circuit boards 10 and 11, in each case by way of a perpendicular contacting element 19, are electrically connected to the strip conductors 18 and 18' of the anode-side and cathode-side ~~[printed]~~ printed circuit board, said strip conductors facing one another. The strip conductors 18 and 18' which on the reaction region side face one another, thus lie opposite one another, only have a slight distance to one another or form a border surface. By way of the bore, the inner-side strip conductors 18 and 18' lying opposite one another, at a location at which this strip conductors lie opposite one another, are accessible from the outside and may be permanently electrically contacted by way of point welding or laser welding.

Please replace the paragraph beginning on page 15, line 25, in the Specification as filed with the following amended paragraph:

Figure 10 shows the cross section through the reaction space of a further embodiment, wherein anode gas distributor structures 24 and cathode gas distributor structures 23 are arranged in an alternating manner on each of the ~~[printed]~~ printed circuit boards 21 and 22, wherein the current collector 1' of the cathode gas distributor is electrically connected to the adjacent current collector 1 of the anode gas distributor via a strip conductor 25.

Please replace the paragraph beginning on page 15, line 36, in the Specification as filed with the following amended paragraph:

The particular preference of this embodiment lies in the fact that by way of the alternating arrangement of the anode-sides and cathode-sides of the fuel cells, one

may do without a contacting of the one side onto the other side of the ~~[printed]~~ printed circuit board composite. The fuel cell in the ~~[printed]~~ printed circuit board composite may thus be realised merely by way of bringing the two ~~[printed]~~ printed circuit boards 21 and 22 onto one another, which is not so tricky with regard to design, and is inexpensive to manufacture.

Please replace the paragraph beginning on page 16, line 13, in the Specification as filed with the following amended paragraph:

With ~~[printed]~~ printed circuit board technology, it is possible to provide a manufacturing technique which is compatible with series production and is reliable for manufacturing fuel cell systems with a relative low electrical output in large batch numbers in an inexpensive and technically less complicated manner. In particular, the electrical series connection, i.e. the contacting of fuel cell to fuel cell of the fuel cell system may be realised by way of a tried and tested industrial method.

Please replace the paragraph beginning on page 16, line 20, in the Specification as filed with the following amended paragraph:

It is furthermore very advantageous that due to the design as a ~~[printed]~~ printed circuit board composite, electronic circuits may be constructed on the fuel cell system in a simpler manner. Such circuits on the one hand may detect, control or improve the behaviour of the fuel cell system and on the other hand however the consumer to be supplied may also be deposited directly onto the ~~[printed]~~ printed circuit board composite. As examples of the first mentioned electronic circuits the following are to be named: electronics for DC-DC conversion, electronics which may be equipped with sensors, for measuring and detecting operating parameters of individual fuel cells (current, voltage, impedance, temperature ect.) electronics for controlling the flows of reactands (activation of microvalves or micropumps), electronics for the protection of